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Cyclone trends constrain monsoon variability during late Oligocene sea level highstands (Kachchh Basin, NW India)

REUTER, M.[1], PILLER, W.E.[1], HARZHAUSER, M.[2], KROH, A.[2]

[1] University of Graz, Institute of Earth Sciences, NAWI Graz, Heinrichstraße 26, 8010 Graz, Austria
email: markus.reuter@uni-graz.at, werner.piller@uni-graz.at
[2] Geological-Paleontological Department, Natural History Museum Vienna, Burgring 7, 1010 Vienna, Austria
email: mathias.harzhauser@nhm-wien.ac.at, andreas.kroh@nhm-wien.ac.at

The Maniyara Fort Formation in the Kachchh Basin (NW India) comprises a succession of vast shell beds composed of larger benthic foraminifers, molluscs and echinoids that were deposited in an isolated inner ramp environment during the late Oligocene. Sediment deposition occurred only during third-order sea level highstands separated by long-lasting erosional gaps. The skeletal components represent a mixture of different marine environments documenting extensive sediment transport from deep to shallow water by severe tropical storms (cyclones). Three major biotic assemblages point to variable storm intensities: (1) shallow storm reworking is indicated by nearshore gastropods, *Clypeaster* echinoids and reef corals; (2) an intermediated storm wave base is reflected in larger benthic foraminiferal (lepidocyclinids) deposits with abundant *Eupatagus* echinoids and corallinacean algae; (3) a deep storm wave base caused high amounts of *Amussiopecten* bivalves and *Schizaster* echinoids in the tempestites. The intensity of tropical cyclones over the recent Arabian Sea is primarily controlled by the strength of the vertical wind shear, which is depending on the strength of the Indian summer monsoon. Accordingly, the reconstructed long-term storm intensity trends from the Maniyara Fort Formation are interpreted to reflect monsoon variability over northern India during the late Oligocene. For the third-order sea level highstand that follows on the Ch2 sequence boundary (~ 26 Ma) the low tempestite frequency and relative shallow storm wave base depth suggest already the action of a relative strong Indian monsoon. In contrast, a weak Indian monsoon is indicated for the next third-order sea level highstand (~ 24 Ma) by frequent tempestites representing a deep storm wave base. This Indian monsoon decline correlates to the temperature maximum of the Late Oligocene Warming and implies that this global temperature rise had largely reduced the land–sea thermal contrast between the tropical Tethys and the Asian continent.